Flood Hazard Mitigation Plan

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Presented To:

Town of Hilton Head Island

Prepared By:

Greenhorne and O'Mara, Inc.

9001 Edmonston Road
Greenbelt, Maryland 20770

Under Contract To:

EDAW, Inc.

3475 Lenox Road
Suite 100
Atlanta, Georgia 30326

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A. Flood Hazard Mitigation Element

This document constitutes the Flood Hazard Mitigation element of the Town of Hilton Head, South Carolina long range Comprehensive Plan. Production of this element is part of an overall effort by the Town of Hilton Head to update the Comprehensive Plan.

1. Comprehensive Plan Update

The Comprehensive Plan reflect desires and priorities of the Hilton Head Island community and also includes the following additional seven elements:

- Population - information related to historic trends and projections of the number, size and characteristics of households; educational levels; income characteristics; race; sex; age and permanent/seasonal population.
- Economy – analysis of the local economy, including historic trends and projections of the numbers and occupational characteristics of the labor force. This includes where people who live in the community work; where people who work in the community reside; wages; major employers; short- and long-term market trends; and the demand for commercial land use.
- Natural Resources – identification and assessment of critical plant and animal habitats; coastal resources; unique scenic views; wetlands; floodplains; soils, air and water quality.
- Cultural Resources - addresses historic landmarks; important archaeological sites; and other unique features, areas and facilities that relate to the history, culture or architecture of the island.
- Community Facilities - analyses of existing and future needs for water and wastewater facilities; solid waste collection and disposal; the roadway network; pedestrian, bicycle and transit facilities; parks and recreational facilities; stormwater management; fire protection; emergency medical services; public safety; government facilities; educational facilities; and libraries, museums and other cultural facilities.
- Housing - includes analysis of existing housing by age and condition; owner and renter occupancy; location; type; affordability; and market absorption and vacancy rates. Also includes housing construction trends, and projections about housing needs to accommodate existing and future populations.
- Land Use - includes existing and future land use by categories, including residential, commercial, industrial, institutional, parks/recreation and open space. Includes future land use maps showing the most appropriate arrangement of land uses and overlay districts based on environmental constraints, existing development patterns, the location and capacity of infrastructure, and resident preferences. Includes appropriate standards for future development with an emphasis on redevelopment activities as well as an emphasis on growth management goals and strategies.

The Town of Hilton Head Island will apply these eight elements to assist policy and planning efforts that will continue into the next century.

2. Introduction to Flood Hazard Mitigation

The Town of Hilton Head Island is susceptible to a variety of natural hazards, including flooding and high winds associated with hurricanes and tropical storms, thunderstorms, tornadoes and the

passage of winter cold fronts. The very physical and geographical features that provide the high quality of life for residents and visitors contribute to these hazards. Of these hazards, flooding resulting from hurricanes is generally thought to pose the greatest threat to the island.

The Town of Hilton Head Island retained the engineering and planning firm of Greenhorne and O'Mara (as a subconsultant to EDAW) as the study planning team to investigate these and other issues related to flood hazards in the community. The Town of Hilton Head Island also formed a planning group of Town staff to assist in review efforts of the flood hazard mitigation study.

B. Flood Hazard Mitigation Goals

The Town of Hilton Head Island has included a review of flood hazard mitigation and flood hazard mitigation planning efforts as part of the Comprehensive Plan Update effort. In December 1993, the Town of Hilton Head Island adopted the first Floodplain Management Plan for participation in the Community Rating System. The Plan was amended in December 1995. Inclusion of flood mitigation in the Comprehensive Plan formalizes these policies and creates a coherent flood hazard mitigation strategy for use by the community over a long-range period.

1. Importance of Flood Hazard Mitigation Planning

The planning process allows the community of Hilton Head Island the opportunity to recognize the types of flood hazards facing the Island, determine the means to address these hazards, and join together to implement these means. Flood hazard mitigation planning allows the community to identify proactive mitigation strategies before a flooding event occurs.

The importance of Flood Hazard Mitigation Planning must be placed in the context of policies, perceptions, and practices associated with flood events that impact the economic and physical wellbeing of the Town of Hilton Head Island.

2. Statement of Goals

Given this understanding of the importance of the flood hazard mitigation element, it is the goal of this planning effort to help guide the Town of Hilton Head Island as it:

- strives to protect the health, safety, and public welfare of its citizens,
- continues to update its Comprehensive Plan,
- updates its Community Rating System requirements, and
- positions itself to receive available State and Federal grant funds for flood hazard mitigation.

3. Achieving Goals

The effort seeks to achieve these goals and objectives by applying several approaches:

- explaining the importance of flood hazard mitigation planning,
- performing a literature search and review of plans, studies and other documents (local, regional, state and federal),
- acquiring flood hazard mitigation data through interviews with local government staff as well as meetings with stakeholders,
- engaging in discussions with and acquiring data from local and regional agencies,

- obtaining and evaluating historic, current, and buildout conditions on the island (particularly related to flood and surge events),
- assessing historic and anticipated flooding events,
- synthesizing existing and new information using GIS approaches,
- assessing the vulnerability to flooding of structures, sites, and wards within the island,
- making recommendations for improving the collection and management of natural flood hazard data,
- assessing flood hazard mitigation incentives and disincentives at work in the Town of Hilton Head Island,
- drawing conclusions from surveys and interviews with citizens and local government staff,
- reviewing on-going and possible flood hazard mitigation activities,
- determining needs to improve flood hazard mitigation efforts, and
- making recommendations for advancing flood hazard mitigation in the Town of Hilton Head Island.

4. Flood Hazard Mitigation Issues

While investigating these approaches, issues associated with Flood Hazard Mitigation include:

- Where, when, and why are flood events likely to occur?
- What are the damages associated with these flood events?
- What are the means to mitigate the effects of these flood events?
- Who needs to be involved in Flood Hazard Mitigation?

Fortunately, the Town of Hilton Head Island already practices in variety of on-going activities and programs intended to address flood hazard mitigation issues. These practices involve federal, state, county, and community efforts. The study will investigate these opportunities, activities, and efforts engaged by Hilton Head Island as a means of recognizing and acting on these goals.

C. Public Involvement

Key to any successful flood mitigation planning process is the establishment of communication linkages within the community. A critical part of this flood hazard mitigation element was development of specific measures to encourage public involvement and to ensure that input occurs throughout the planning process.

1. Education

The Town of Hilton Head Island takes a proactive approach to inform the community of flood hazard mitigation opportunities and processes. These education efforts are targeted at both residents and visitors to the Island.

The Town produces pamphlets and brochures with information on different aspects of flood hazards and flood protection programs (as well as providing other State and Federal literature). These materials are placed in schools, libraries, and other public venues.

The Town of Hilton Head Island also sponsors an annual Flood Awareness Week that focuses the community on all aspects of flood hazard identification, prevention, protection, and policies.

The Town enlists newspaper, radio, and other media outlets to assist in providing this information to the public.

The Town also cooperates with National Flood Insurance Program (NFIP) staff to educate the public and insurance agents on current practices and programs. NFIP staffers described that a recent NFIP sponsored seminar on Hilton Head Island was "very well attended" by the Island's insurance agents. An indication of the success of such efforts are the over 27,000 NFIP policies currently covering Hilton Head Island (NFIP, 1998).

2. Town Council Meetings

On the evening of November 19, 1997, the study group presented Town of Hilton Head Island Council members with an overview of the approach and methods to be incorporated into the flood hazard mitigation element (as well as describing other elements of the Town of Hilton Head Island comprehensive plan).

Present at the meeting were the Council, including the Mayor, members of the Town Planning Commission, members of the public, and Town staff.

During presentations, it was noted that prior versions of the Town of Hilton Head Island Comprehensive Plan had little or no information related to flood hazard mitigation. The Town Council included this element within the plan update based on an understanding of the Council the importance of such inclusion and within a context of strong advocacy and support by Town staff.

Council members contrasted the flood element efforts with the Island Wide Drainage Study efforts completed earlier (and in the process of implementation). Discussions related the similarities and differences of these efforts and the objectives of each.

Throughout the comprehensive plan update process, the Town Council has been provided status reports on the progress and analyses yielded by all elements of the plan.

3. Stakeholder Meetings

Formally and informally throughout the update process, members of the planning team met with stakeholders of Hilton Head Island. Stakeholders included citizens, activists, developers, advocates, Town staff, and other parties interested in the planning process (other portions of the comprehensive plan detail the scope of these Stakeholder interactions). Meetings took place via face-to-face discussions and interviews, telephone conversations, correspondence, and other means. Topics included a broad range of issues related to updating the comprehensive plan, including the flood hazard mitigation element.

During these interactions, topics such as building code, freeboard, water and wind damage, development, beach setbacks, and other issues engendered lively technical, economic, political, policy, and social discussions. In some cases, conflicts arose over balancing competing priorities in the community, and through extension, the updated comprehensive plan. Discussions yielded insights incorporated into the flood hazard mitigation element and other comprehensive plan elements.

4. Public Visioning Workshops

To best reach the desired level of public involvement in the planning process, the planning team designed a system of Public Visioning Workshops held at multiple locations on the Island. As the entire area of the Island is floodprone, the team situated workshop venues to encourage diversity in the geographical and demographic constituents of Hilton Head Island.

Pre-workshop publicity materials, such as flyers, notices, and web pages, encouraged the public to be prepared to discuss topics such as drainage, flood insurance, types of flood hazards, flood problems and solutions and other issues of interest.

Each workshop was identical in format and included planning team presentations of the overall comprehensive plan update, the role of the Flood Hazard Mitigation plan as an element within it, and observations concerning flood hazard mitigation issues. The focal point of each Public Visioning Workshop was a lengthy time of open discussion among the participants. These discussions have allowed the planning team to gleam from the wisdom, experience, opinions, and vision of the Town's residents. In this manner, the workshop focus allowed the public to participate and assist in the creation of the element.

Generally, discussion of the flood hazard mitigation issue tended to be focussed on the causes of current drainage problems on the island and the need for short-term solutions to these problems. It was also clearly expressed, however, that planning for long-range solutions is imperative in order to mitigate serious flooding problems in the future.

During each workshop, residents from every location on the Island expressed frustration with flooding in their neighborhoods and their sense that the frequency of such events was increasing over the last few decades.

Details on each workshop, including specific issues raised are described below:

A. Hilton Head Island Town Hall

This morning workshop was held from 9:00 to 11:30 a.m. on March 19, 1998 in the Council Chambers of the Hilton Head Island Town Hall. Thirty-four persons attended the workshop, including members of the public, Town Council, and the Town's Planning Committee. Many of the participants were well informed on the issues related to flood hazards and flood hazard mitigation. In addition to general discussions on the impacts of flood hazards on the community, specific issues included:

- The Town of Hilton Head Island should continue to take a proactive approach to planning for flood hazard mitigation.
- As the Island is already recognized as an effective community in the United States in terms of preparedness for a major flood or hurricane, there is a foundation upon which to build and to address additional problems such as flooding resulting from drainage deficiencies on the island.
- Are capital resources of the Town sufficient to solve flooding problems?

B. Saint Luke's Episcopal Church Workshop

This workshop was held from 1:00 to 3:00 p.m. on March 19, 1998 in the parish hall of Saint Luke's Episcopal Church. Eighteen persons attended the workshop. Many participants had

questions about issues related to flood hazards and flood hazard mitigation. In addition to general discussions on the impacts of flood hazards on the community, specific issues included:

- The role in the FEMA and the Town of Hilton Head Island in providing flood insurance to the community. Discussion described how 1994 reforms changed in the manner the NFIP provides coverage, in particular to cumulative substantial damages.
- Development and Redevelopment should be limited in terms of impervious surfaces and the footprint size of a building on a property.

C. McCracken Middle School Workshop

This workshop was held from 6:00 to 8:00 p.m. on March 19, 1998 in McCracken Middle School media center. At least 30 people registered at this workshop (more attended but did not register). Many participants had questions about issues related to flood hazards and flood hazard mitigation. In addition to general discussions on the impacts of flood hazards on the community, specific issues included:

- Maintenance of stormwater drainage infrastructure on the island must be improved. The Town of Hilton Head Island should work more closely with the State and County governments to ensure that drainage systems associated with roads under their jurisdictions are properly maintained.
- An increased level of cooperation among public and private entities is needed to solve island-wide drainage problems.
- The Town's Land Acquisition Program should coordinate with solutions being sought for Island Wide Drainage Study so that sites could be purchased which may assist in Island stormwater drainage management.
- Improvements in the Public Service Districts' (PSD) levels of sewage provision to certain areas of Ward 1 can be seen as a way to prevent health hazards that may result from flooding. There is a current need to prevent the mixing of septic sewage and stormwater drainage and flooding in certain areas of the Island. The Town Council should act as a facilitator to ensure that the PSD's implement sewage extension in a timely manner.

5. Visits to Floodprone Areas

Residents in northern, unaffiliated portions of Hilton Head Island expressed a desire that the comprehensive plan team members investigate flooding areas in that portion of the Island. With the assistance of members of the community, this was accomplished during a visit in March 18, 1998.

The evening and night before the visits (March 18, 1998), the Hilton Head Island vicinity received approximately 3 inches of rainfall. This is less than the 25-year design storm of 8 inches of rainfall for a 24-hour period used for stormwater design.

This older developed area of the Island community is typically served by ditches and swales for draining stormwater. In some cases, the drainage ditches have become filled with sediment, resulting in lost hydraulic capacity. Some areas exhibited recent evidence of the use of mechanical devices to clean out ditches. Drainage channels in other areas appear to have lost up to 50 percent of their capacity, possibly as a result of recent upstream development (both large-scale and through subdivision).

To assist in alleviating these types of problems, the Town of Hilton Head Island conducts periodic inspections of ditches and swales. However, the Island has limited powers to enforce State, County, and private compliance with acceptable maintenance practices.

The site visits illustrate some of the issues that the Town of Hilton Head faces when investigating and performing flood mitigation. The March 18 event did not qualify as a design event; however, residences and properties experienced flooding. Projects are underway to alleviate portions of the flooding, but these will take time to fund and complete (also such projects typically are constructed downstream to upstream; and some of these areas lie in interior portions of the Island).

D. Agency Coordination

Several levels of agency coordination took place during the development of the Flood Hazard Mitigation element. Some of these coordination activities were associated with specific issues, other were part of the on-going communication process engaged by the Town of Hilton Head Island as part of their flood hazard mitigation activities.

1. Literature Search

A literature search revealed the following flood hazard mitigation (and related efforts) reports and data specific to the Town of Hilton Head Island[1]:

- Post-Disaster Recovery and Mitigation Plan (TMAC, 1993)
- Flood Insurance Study for Beaufort County, South Carolina (FEMA, 1986)
- The Town of Hilton Head Island Floodplain Management Plan (1995)
- Disaster Preparedness Plan (1997)
- Repetitive Loss Projects, Progress Report (1995)
- Flood Warning Program, Progress Report (1995)
- The Standard Building Code (1997)
- Beaufort County – Emergency Operations Plan (1990)
- Beaufort County Zoning and Development Standards Ordinance (BCZDSO) (1995)
- Selected elements of the Town of Hilton Head Island Comprehensive Policy Plan (1998)
- Flood Mitigation Assistance Project Grant Application (1997)
- South Carolina Stormwater Management and Sediment Control Handbook (1997)
- The Town of Hilton Head Island – Island Wide Drainage Study (1995)

These and other associated literature reveals that Hilton Head Island officials have a comprehensive understanding of the issues involved in flood hazard mitigation. Policies and procedures, in most cases, compliment the requirements of successful flood mitigation approaches.

[1]These documents were reviewed and used during the course of this study.

Additionally, most of these documents provide the details that supplement an overall flood hazard mitigation plan. The wide ranging scope of the items investigated and documented provide flexibility in updating any specific component to respond to physical, economic, and demographic changes on the Island.

2. Interviews

This study conducted a series of interviews with Town and Beaufort County staff to gain additional information and insights on the status of Flood Hazard Mitigation. Discussions reveal a high level of awareness and considerable effort directed toward hazard mitigation. Most of the efforts appear focused on flood-related issues: localized flooding, stormwater management studies and drainage projects. Town and local staffs are aware of the potential impacts of hurricane winds. However, their efforts are hampered by more frequent flooding and drainage problems and relative scarcity of funds for wind mitigation.

A. Hilton Head

The November 1997 Town of Hilton Head Island interview involved discussions with several representatives of the Town concerned with hazard mitigation. Salient points revealed by the interview include:

- The Town of Hilton Head Island is well prepared in flood hazard mitigation policies and procedures.
- Significant efforts have been made to increase public awareness.
- Efforts to maximize credits under the CRS have improved flood mitigation policies and benefited policy holders
- Recent population growth is expected to continue – this will make a comprehensive response to future flood hazard mitigation even more important.
- In the past, the “limited government” philosophy of the Town made some efforts in understanding the magnitude of flood events difficult since portions of the Island may be effectively “off limits” to some Town staff after these events.
- Future mitigation projects are limited by financial resources and staff time.

B. Beaufort County

During the same November 1997 period, a hazard mitigation interview was also conducted with representatives of Beaufort County. To aid in their understanding of County perspectives, members of Town of Hilton Head Island staff also attended the meeting. Key elements of County assessments are:

- The Town needs to improve its response plan and eliminate duplication of effort
- Maintenance issues are significant for drainage systems; much of this is a result of State and County policies and practices
- Recent population growth is expected to continue, including more immigrants whose primary language is not English; this will hamper ability of officials to assist the entire population in the event of an emergency

- Types of development on the island are expected to change (examples cited were elderly housing and assisted living projects). These will lead to additional pressures in emergency response.
- Lack of resources may limit mitigation activities

C. Coordination Opportunities

Differences in viewpoint notwithstanding, the interviews revealed a good level of understanding and coordination between Town and County officials. To date, Town of Hilton Head Island policies and practices show a community very well prepared to address flood mitigation issues. This allows the focus of this study to concentrate on how the Island can not just build, but improve these efforts. Given the recognized limitations of funding sources available for the community, this concentration will be critical to the viability of mitigation efforts.

3. Coordination with County and State Practices and Policies

The Town of Hilton Head Island has an excellent reputation for innovative and responsive flood mitigation practices from state and federal agencies.

A. Reviews of Flood Hazard Mitigation Element

State and independent agencies reviewed draft versions of this document and provided comments and suggestions. These were incorporated into subsequent versions of the element. These suggestions enabled the Town of Hilton Head Island Flood Hazard Mitigation element become consistent with the visions and approaches of other communities on a statewide basis. The result will be stronger interaction with the element and other practices.

B. Review of South Carolina Flood Hazard Mitigation Document

On-going South Carolina efforts have developed a draft Flood Hazard Mitigation document that is intended to coordinate State agencies and programs (Hazard Mitigation Technical Assistance Partnership, 1998). The document purpose is primarily intended to aid these agencies in helping County and local governments to recognize and administer their Flood Hazard Mitigation practices. The document recognizes Hilton Head Island implementation of flood hazard mitigation practices. The study reviewed the document and communicated with the author in an attempt to ensure that the Flood Hazard Mitigation element provided complementary approaches to these statewide efforts (Flood Hazard Technical Assistance Partnership, 1998).

C. Flood Mitigation Assistance Program

The Flood Mitigation Assistance Program (FMAP) is a federally funded and state administered program that provides grants to South Carolina communities for flood hazard mitigation projects. The Town of Hilton Head Island received such a grant in 1997/1998. To qualify as recipients of these grants, the Town of Hilton Head Island produced an application detailing a mitigation project designed to control flooding within the Jervis Creek region of the Island.

4. Coordination with Federal Flood Hazard Mitigation Policies

To assist in aiding victims of flood events and preventing future damages, in 1968, the federal government created the National Flood Insurance Program. The NFIP is administered by the

U.S. Federal Emergency Management Agency (FEMA) and 18,000 communities nationwide. The program encourages participating communities to enact and enforce regulations designed to decrease the likelihood of damaging flood events. The program also defines flood elevations associated with substantial storms or other events (NFIP defines such an event based on an annual probability of likelihood of 1 percent or a 100-year flood event). In return, NFIP provides Federally backed flood insurance policies – useful in areas where private insurance may hesitate to provide coverage. The Town of Hilton Head Island participates in the NFIP and applies flood elevation protection criteria through building code and other local ordinances.

The NFIP provides a community with *minimum* standards that provide a measure of protection against flood hazards. The Town of Hilton Head Island implements a higher level of flood hazard mitigation efforts than contained within these standards. To recognize, encourage, and support such additional efforts, FEMA created an additional program, the Community Rating System (CRS). The CRS provides communities with opportunities and incentives to improve flood management through efforts and activities such as:

- Protection of public health and safety
- Promotion of awareness of flood insurance
- Reduction of flood losses to insurable structures
- Facilitation of accurate policy information
- Reduction of erosion risks and damages
- Protection of natural and beneficial floodplain functions

The CRS incentives are reductions in the cost of the flood insurance rates. Each community participating in the CRS receives credits for "preparing, adopting, implementing, evaluating, and updating a comprehensive floodplain management plan" (FEMA, 1996). The greater the number of credits, the larger the insurance premium reduction.

These categories have been codified into a planning process for flood hazard mitigation that is used in a variety of related contexts such as eligibility for grant funds and Federal water resources projects (Philipsborn, 1998). Therefore, receiving maximum CRS credits reduces policies rates, protects the community, and provides avenues to financial resources.

The Town of Hilton Head Island ranks at the top of FEMA compilations with regards to credit in the CRS, with a 20 percent premium discount for policyholders (FEMA, 1998). Nationally, few communities have better ratings than the Town of Hilton Head Island does. The Island is within the top 2 percent of communities nationwide with regard to this program (FEMA, 1998). Such discounts have an advantage in that they promote the suitability of the Island for economic development.

5. Review of Other Experiences in Hazard Mitigation Planning

One means to determine areas of improvement is to review experiences of other communities. The positive experience on the Town of Hilton Head Island can be contrasted with those of other communities located in the southeastern United States. Analysis of these experiences provides an illustrative guide to the pitfalls of such planning processes. By recognizing and apply strategies to avoid these pitfalls, the Town of Hilton Head Island will continue to provide the community with a high level of responsive flood hazard mitigation planning.

A recent study by Smith and Deyle (1996) investigated nine communities in the Florida Panhandle to determine whether and to what extent hazard mitigation plans and long-term redevelopment plans affected response and recovery following Hurricane Opal. Their 1996 study (and a forthcoming chapter in an American Planning Association report report[2]) concluded that the plans, if they existed, had little effect on recovery following Hurricane Opal. Despite significant differences in the status of hazard mitigation and long-term redevelopment plans in the nine communities, Smith and Deyle found all nine communities followed a "remarkably similar" recovery process. This recovery process largely ignoring any written policies and plans that had been developed. This conclusion, and others described below, provide compelling rationale for rethinking the entire hazard mitigation and planning process. Based on their Hurricane Opal study, Smith and Deyle concluded that:

- Planning as a process, and plans that have been produced, played only a minor role in the recovery process.
- The plans lacked meaningful policies for handling storm issues. Where those policies existed, they tended to focus on the short-term recovery process, not the long-term process.
- The plans generally failed to obligate the local government to any particular policy or specific course of action.
- Local governments exhibited a widespread lack of interest in controlling land use and development for the purposes of hazard mitigation.
- The short-term focus promoted the view that Local Government Comprehensive Plans were largely irrelevant to the recovery process.
- Local decision-makers did not engage in a formal process of identifying issues, defining goals, and evaluating alternative recovery strategies.
- All nine communities explicitly or implicitly defined "rebuilding as quickly as possible" as the main post-storm recovery goal -- all pursued this goal "diligently."

The authors of this element note that based on observations following natural disasters throughout the United States, observations of Smith and Deyle following Hurricane Opal are generally the rule, not the exception. This is not to say that "rebuilding as quickly as possible" is an inappropriate course of action -- it is highly desirable that homes, businesses, infrastructure and services be restored quickly so that a community can minimize disruptions and economic losses. However, the fact remains that, with few exceptions, the individual and community focus on rapid recovery is a powerful engine that tends to push aside efforts to reduce the risk of future losses in any significant way. The implications of these findings will be discussed in later portions of this study.

E. Assessment of Flood Hazards

The Town of Hilton Head Island flood hazards are largely tied to geologic and topographic drainage features throughout the island and location (horizontal and vertical) of structures relative to the floodplain. Associated with some flooding events are wind hazards, principally dependent upon the nature (type) of construction, and condition of construction in the island.

[2] Chapter 6 in "Planning for Post-Disaster Recovery and Reconstruction," American Planning Association, in forthcoming *Planning Advisory Service Report* to be published in 1998.

1. Map of Flood Hazards

There is no location on the Island free from some form of flood hazard or that has not been affected by flooding in the past. This observation is in contrast with most other communities in the United States. When investigating the location of such flood hazards, typical practice analyzes the extent of large-scale design events on a community. These design events are normally based on a 100-year probabilistic storm event, or an event that has a one-percent annual chance of occurring. The area affected by this event is typically referred to as the floodplain (even on Islands such as Hilton Head where it would difficult to describe a plain).

A. Hilton Head Island Floodplain

As part of efforts to develop the NFIP, FEMA investigated the possible frequency and magnitude of flooding events within Beaufort County (including the Town of Hilton Head Island). The results of these analyses by FEMA form the Beaufort County Island Flood Insurance Study (FIS) (FEMA, 1986). The FIS applied a computer model, TTSURGE, which predicted levels of wind surge and inundation for the 100-year storm event.

Simply described, during a storm event, offshore wind and wave combine to produce elevated water surface elevations. In this context, these increased elevations are referred to as the wind surge or storm surge. Typically, the more severe the storm, the larger the surge height. These surges sweep shoreward and cause flooding of coastal areas. In areas expected to experience higher wind strengths during these storms (i.e., beachfront areas) the surge experiences further increases in elevation as a result of wind velocity action. (The “worst” storm scenario analyzed in the FIS would result from a hurricane, making landfall just south of the Island.)

FEMA used the resulting model data to produce elevations at which structures could theoretically be protected from these surge effects. These elevations are related to the 100-year storm frequency. The compendium of these elevations produced the FEMA Flood Insurance Rate Map (FIRM) (FEMA, 1986), illustrated by Figure 1

The FIRM distinguishes extent and magnitude of floodprone areas by dividing the Island into a series of flooding zones (V, A, B, and C). Zones with a “A” or “V” designation are areas that expect flooding from the 100-year storm. “V” (or velocity) zones are areas where wind and wave will produce additional water surface elevations during a storm event. Each “V” and “A” zone have two further numbers that indicate the associated hazard and predicted elevation within that zone.

The flood hazard factor (FHF) is a relationship between depth and frequency, used to note areas of special tendency to wave and other action. A higher value indicates a higher expected hazard.

The predicted elevation is the expected height of flooding above National Geodetic Vertical Datum (NVGD), in feet. The “C” zones are those areas not expected to experience flooding. The “B” zones would expect a foot of flooding or less (not quite the 100-year level, but also not dry). Therefore, a “A9(18)” is an “A” zone with a FHF of 9 and expected flood elevation of 18 feet above the mean sea level.

The FIRM for the Town of Hilton Head Island reveals that very few portions of the island are not vulnerable to flooding resulting from storm surges and hurricanes. An estimated 83 percent of the island’s land area (28.5 of 34.4 square miles) lies within a mapped floodplain (zones V and A).

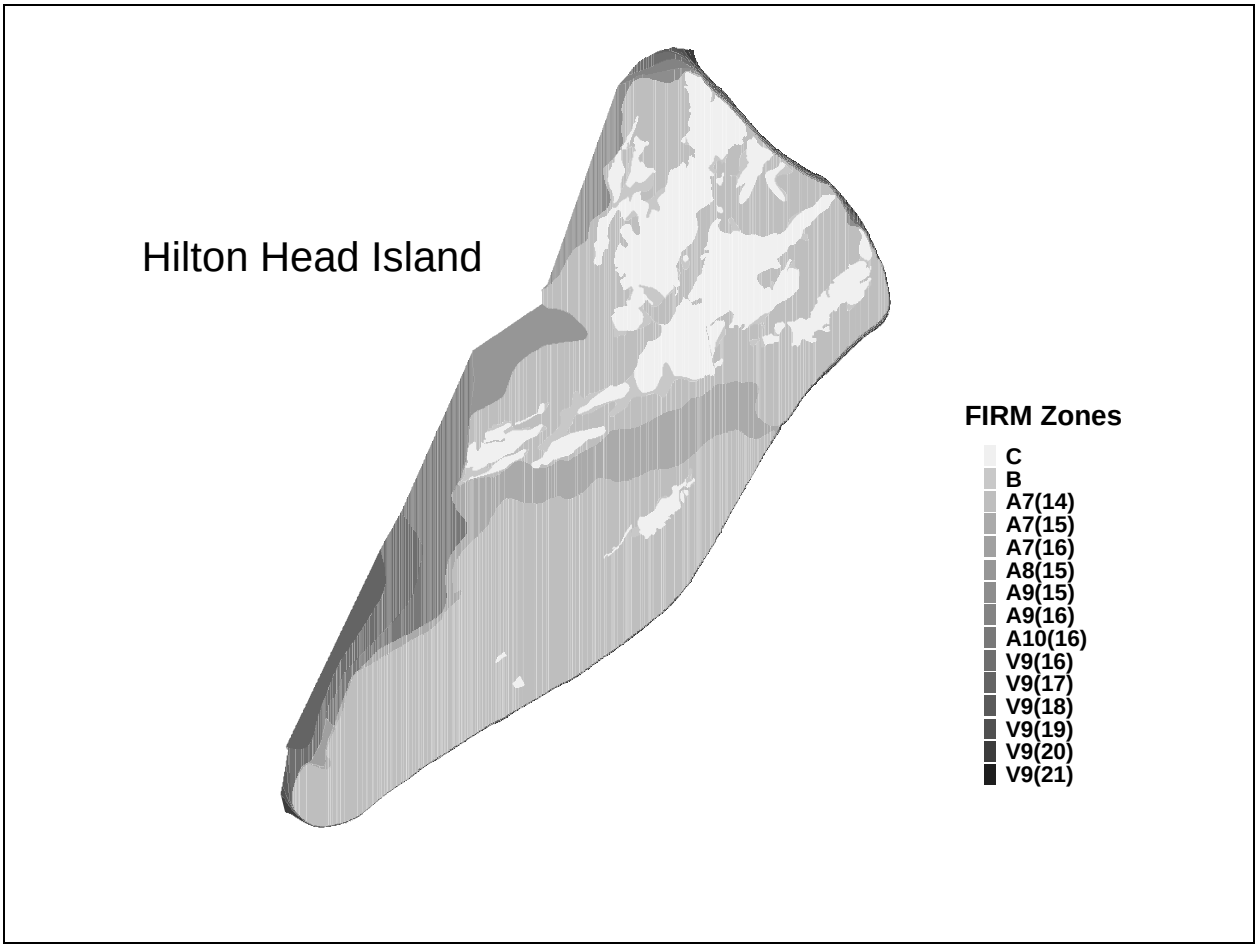

Figure 1. Hilton Head Flood Insurance Rate Map.

The FIRM also reveals that beyond relatively "thin" areas along the southeastern coast of the Island, the most severe areas of flood impact lie along the southern tip, the western Island portion adjoining the Sound and along the upper northeast coastal portions.

Most of the areas designated as "B" and "C" zones fall within the northern interior of the Island, along older geologic portions of the barrier island formation. Not surprisingly, these are also areas of the highest elevation on the Island.

The FIRM map is an integral part of the Town of Hilton Head Island's efforts to mitigate potential flood hazards. As the Town reaches ultimate development levels anticipated under the comprehensive plan, these elevations will probably no longer reflect the true effects of storm surges caused by hurricanes. The reason is that TTSURGE uses the physical layout of the landform (including structures such as buildings) in each predictive transect to determine resulting elevations. Adding (or reducing) development will affect the ultimate elevations for the island. (The Town of Hilton Head Island has already noted changes in the floodplain between the original 1977 FIRM and later 1986 versions.)

Another factor affecting accuracy of FIRM elevations is the number of storms used to produce the frequencies applied in the model. The average frequency of hurricane and tropical storm

occurrence described earlier dates the information used to determine the 1986 probabilistic distribution. For example, these distributions do not account for storms such as Hugo and Bertha.

Additionally, except for a limited manner (associated with the description of a "B" zone), the Town of Hilton Head FIRM does not account for the effects of storm rainfall on flooding events. In a major event, these hydrological effects will tend to exacerbate the surge based flooding. This observation is based on several factors.

The "flat" nature of the island will contribute to incidences of flooding. As water flows downstream, despite stormwater controls, the effect should be an accumulation of water volume within lower portions of a watershed.

Additionally, other elements of the comprehensive plan have described the effects of the soil infiltration in determining flood prone areas. Notice that those areas having the highest ground elevations on the Island ("C" zones) are also those areas that have soils that drain poorly. In effect, these areas might not be impacted by storm surges, but would certainly be affected by the corresponding rainfall volumes.

Finally, while the storm surges occur, the underlying soils will become saturated. Even after surges recede from the Island the overall infiltration capacity of the Island is less than normal, increasing danger from subsequent rainfall events.

2. Sources of Flood and Wind Hazards

For both flood and wind vulnerability, primary causes of hazards include the effects of hurricanes, tropical storms, tornadoes, and thunderstorms upon the island. The following presents a discussion of these sources, as related to the Town of Hilton Head Island.

A. Hurricanes & Tropical Storms

Tropical Storms have sustained winds averaging 39 to 74 mph. When sustained winds intensify to greater than 74 mph, the resulting storms are called hurricanes. Hurricanes are divided into five classes according to the Saffir-Simpson hurricane scale (depicted in Table 1), that uses wind speed and central pressure as the principal parameters to categorize storm damage potential. For comparison sake, the FIS used a category 3 hurricane to produce the FIRM zones, extents, and elevations.

Literature reports that major hurricanes have produced flooding in 1787, 1804, 1893, 1940, and 1959 (FEMA, 1986). A review of historical tracks of tropical weather systems indicates the Town of Hilton Head Island has been affected by such storms over 40 times during the past 105 years (from 1893 to 1998). As shown in Table 2, 23 hurricanes, 16 tropical storms and 3 subtropical depressions have passed over or within approximately 50 miles of the Town of Hilton Head Island since 1891 (NWS, 1998).

These only represent the hurricanes passing within the 50-mile radius. Numerous severe storms have struck the Atlantic Coast both above and below the Island, including Hugo (1989), Bertha (1996), and Bonnie (1998). The predicted paths of Hugo and Bertha were "close" enough to Hilton Head Island (although greater than the 50-mile radius) that local officials involved in emergency operations instituted mandatory evacuations of residents and visitors from the Island.

Table 1. Saffir-Simpson Hurricane Scale.

Category	Central Pressure Inches	Wind Speed Miles/Hour	Surge Height Feet	Damage
1	*≥ 28.94*	*74 - 95*	*4 – 5*	*Minimal*
2	*28.50 – 28.91*	*96 - 110*	*6 – 8*	*Moderate*
3	*27.91 – 28.47*	*111 - 130*	*9 – 12*	*Extensive*
4	*27.17 – 27.88*	*131 – 155*	*13 – 18*	*Extreme*
5	*< 27.17*	*> 155*	*>18*	*Catastrophic*

Source: Dolan and Davis 1992

Table 2. Hurricanes and Tropical Storms in Hilton Head Island Vicinity.

Date	Type	Name	Wind Speed	Date	Type	Name	Wind Speed
8/28/1893	*Hurricane*	*-*	*95*	*9/27/1894*	*Hurricane*	*-*	*75*
8/31/1898	*Hurricane*	*-*	*85*	*10/2/1898*	*Hurricane*	*-*	*85*
10/12/1900	*Tropical Storm*	*-*	*35*	*11/4/1904*	*Tropical Storm*	*-*	*35*
10/19/1910	*Hurricane*	*-*	*60*	*8/28/1911*	*Hurricane*	*-*	*65*
7/15/1912	*Tropical Storm*	*-*	*45*	*10/4/1916*	*Tropical Storm*	*-*	*30*
9/16/1924	*Hurricane*	*-*	*40*	*9/30/1924*	*Tropical Storm*	*-*	*35*
10/3/1927	*Tropical Storm*	*-*	*50*	*9/18/1928*	*Hurricane*	*-*	*60*
9/15/1932	*Tropical Storm*	*-*	*40*	*5/29/1934*	*Tropical Storm*	*-*	*50*
8/11/1940	*Hurricane*	*-*	*65*	*10/20/1944*	*Hurricane*	*-*	*50*
9/17/1945	*Hurricane*	*-*	*45*	*11/3/1946*	*Tropical Storm*	*-*	*20*
10/15/1947	*Hurricane*	*-*	*75*	*8/31/1952*	*Hurricane*	*Able*	*90*
9/1/1953	*Tropical Storm*	*-*	*30*	*9/21/1953*	*Tropical Storm*	*-*	*25*
9/27/1953	*Hurricane*	*Florence*	*35*	*6/9/1957*	*Tropical Storm*	*-*	*35*
9/29/1959	*Hurricane*	*Gracie*	*105*	*8/29/1964*	*Hurricane*	*Cleo*	*40*
9/13/1964	*Hurricane*	*Dora*	*40*	*6/10/1966*	*Hurricane*	*Alma*	*40*
5/26/1970	*Hurricane*	*Alma*	*25*	*9/13/1972*	*Hurricane*	*Dawn*	*30*
9/15/1976	*Subtropical Storm*	*-*	*40*	*9/4/1979*	*Hurricane*	*David*	*80*
6/18/1982	*Subtropical Storm*	*-*	*60*	*9/29/1984*	*Tropical Storm*	*Isidore*	*45*
7/25/1985	*Hurricane*	*Bob*	*65*	*8/9/1985*	*Hurricane*	*Claudette*	*25*
10/12/1985	*Tropical Storm*	*Isabel*	*25*	*8/15/1986*	*Hurricane*	*Charley*	*15*
8/28/1988	*Tropical Storm*	*Chris*	*35*				

Additionally, as seen in Figure 2, Beaufort County has been the landfall site of eight Category 1 and 2 and one Category 3 hurricane since the turn of the century. Hence, these data show:

- A tropical system passes over or near the island an average of once every 2 years.
- A tropical storm or hurricane passes over or near the island an average of once every 2½ years.
- A hurricane passes over or near the island once every 5 years.

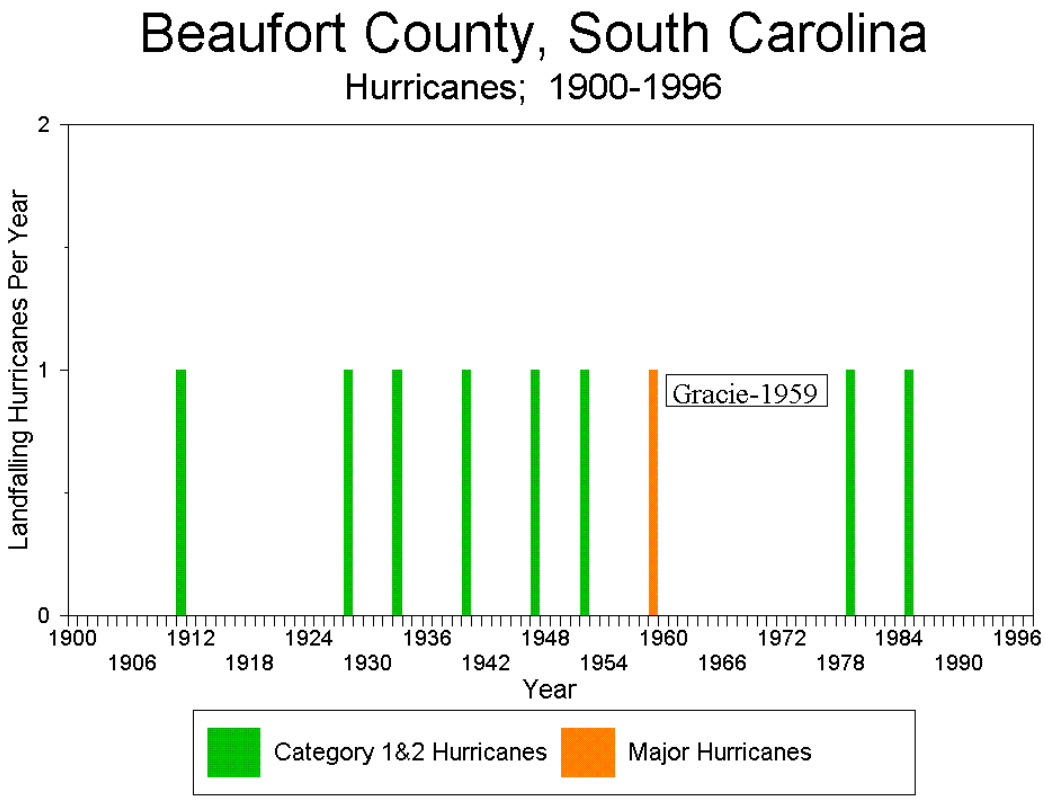

Figure 2. Landfall hurricanes in Beaufort County.

The most common tracks for tropical systems affecting the Town of Hilton Head Island are from southeast to northwest. The last major hurricane to strike Beaufort County (Hurricane Gracie) followed this route.

The most potentially damaging hurricane would occur from this direction - striking the coast approximately 25 to 35 miles south of the island. This type of landfall is the “Entering Hurricane” scenario used in preparing surge height estimates for the island (FEMA, 1986).

From these data, it can be noted that although it is expected that a hurricane would pass over or near the Island every 5 years, the last hurricane to meet these criteria was Charley in 1986. Likewise, it has been 10 years since the last tropical storm passed near Hilton Head Island. This appears to be the largest gap in the historical record. Although it is beyond the scope of this study to make predictions of storm behavior, it appears prudent for emergency planners to expect some form of storm to pass the area in the near future.

In this manner, the evacuations triggered by hurricanes Hugo and Bertha assisted Town of Hilton Head Island and County officials in planning, testing, and refining responses to prepare for these future events.

B. Thunderstorms, Nor'easters, and Other Storm Events

It might be expected that the biggest cause of flooding in the island would be associated with the passage of large storms such as hurricanes. In reality, many large rainfall volume storms affecting the island are not associated with the passage of a tropical storm or hurricane (NWS, 1998).

Such storms are attributable to cyclonic events such as thunderstorms and extratropical storms (e.g., nor'easters). These systems form whenever unstable air produces significant temperature and pressure differences. These events rarely obtain hurricane level wind speeds.

A classification system for northeasters was proposed by Halsey (1986) and later modified by Dolan and Davis (1992), but is not yet as widely accepted as the Saffir-Simpson hurricane classification. The Dolan-Davis classification (see Table 3) is a five-step classification that uses deepwater significant wave height and duration to define storm power and categorize likely storm impacts (e.g., beach and dune erosion, dune breaching, and property damage).

Table 3. Dolan-Davis Northeaster Storm Scale.

Storm Class	Beach Erosion	Beach Recovery	Dune Erosion	Dune Breaching	Property Damage
Class 1 (weak)	*Minor changes*	*Full & usually immediate*	*None*	*No*	*No*
Class 2 (moderate)	*Modest: confined to lower beach*	*Full*	*None*	*No*	*Minor, local*
Class 3 (significant)	*Erosion: extends across entire beach*	*Usually recovery over considerable period of time (months)*	*Can be significant*	*No*	*Loss of many structures at local scale*
Class 4 (severe)	*Severe beach erosion and recession*	*Recovery seldom total*	*Severe dune erosion or destruction*	*Where beach is narrow*	*Losses of structures at community level*
Class 5 (extreme)	*Extreme beach erosion (up to 50 meters in places)*	*Permanent & clearly noticeable changes*	*Dunes destroyed over extensive areas*	*Wide-spread*	*Extensive regional scale (millions of dollars)*

Source: Dolan and Davis, 1992

Typically, the effects of such storms are manifested by high intensity, low duration rainfalls (such as in a thunderstorm). However, these storms may be also associated with slow moving, long duration, rainfall events (such as when a system stalls off the coast). In this case, the effects are long periods of rainfall and severe wave damage to coastal areas.

In contrast, hurricanes move across the island more rapidly and produce severe, but localized, areas of high rainfall. The volume of rainfall actually falling on the island during a hurricane can be less than rainfall volumes falling on the island during a thunderstorm. The October 1994 storm that caused flooding and damage on the Island was an example of such an event.

The effects of these storms can be illustrated by contrasting average daily rainfall depth between hurricane and tropical storm events and other storm events. Between January 1958 and December 1981, the average daily rainfall depth equaled to 0.46 inches (2666 observations). The average hurricane/tropical storm produced 0.87 inches of rainfall per day (26 observations) over the storm period. In the same period, there were 410 storms, not related to a hurricane or tropical storm that had daily rainfall depths greater than 0.87 inches! The average daily rainfall depth of these 410 events equaled 1.56 inches, nearly 80 percent larger than the average hurricane/tropical storm event. Of course, some hurricane events, such as David, did produce a large quantity of average daily rainfall. However, the conclusion remains that these other storms events contribute a significant rainfall volume to the Island on a regular basis.

The cumulative effect of these storms can overwhelm the stormwater management and infiltration capacities of Island watersheds. For example, the stormwater management system in the Ward One portion of the Island consists of a series of roadside ditches and swales. The mild slope associated with such appurtenances mean that there is very little slope to enable efficient transport of water from front yards to outlets. Ponding appears to be a common problem after storm events. A successive series of minor rainfall events can “fill-up” these ditches, reducing their ability to assist in controlling the effects of a “final” rainfall event.

C. Tornadoes

Available historical data obtained from the National Weather Service (NWS) reveal that from 1950 to 1995, 12 tornadoes, ranging from Fujita-Pearson class F0 to class F1, have struck Beaufort County (NWS, 1998). Table 4 depicts the incidences of these tornadoes occurring near the island. The historical record shows that the majority of tornadoes in the Town of Hilton Head Island occurred between April to November. However, it is conceivable that a tornado could strike the island during any portion of the year.

Table 4. Tornadoes in the Hilton Head Island Vicinity.

Date of Storm	Fujita-Pearson Class	Date of Storm	Fujita-Pearson Class
September 25, 1956	F0	June 16, 1985	F0
April 12, 1961	F1	June 30, 1994	F0
October 7, 1965	F1	June 5, 1995	F1
October 7, 1965	F1	June 12, 1995	F1
May 29, 1973	F1	November 7, 1995	F1
May 3, 1984	F1	November 7, 1995	F0

The low number of recorded tornadoes, 12 tornadoes in the noted 45 year period, is at variance with the frequency of 1 to 3 per year documented by FEMA (FEMA, 1990). During interviews,

officials felt that tornadoes were the second most important wind hazard facing the Town of Hilton Head Island.

3. Hilton Head Island Hydrology

To better understand the effects of these storm events on Hilton Head Island requires a discussion of the process and variables that affect the deposition of these volumes of rainfall. This study of interaction of precipitation and earth is referred to as hydrology.

The hydrologic cycle describes the transition of water from the atmosphere; onto the earth; the conveyance across and under the surface; collection into water bodies; and replacement into the atmosphere through evaporation and transpiration. Water constantly moves through this cycle according to a variety of natural processes as is shown in Figure 3.

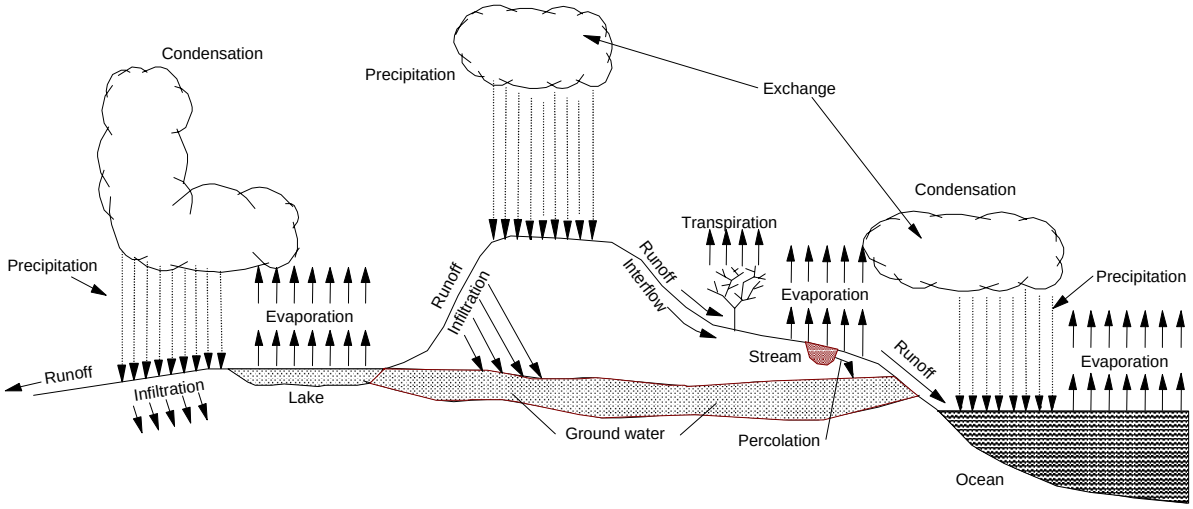

Figure 3. Hydrologic cycle.

Understanding of the hydrologic cycle provides a valuable context for applying hydrologic techniques to flood hazard mitigation.

The hydrologic cycle includes storage of water in:

- the atmosphere; e.g., clouds and humidity
- the land surface; e.g., streams, lakes, the ocean, and vegetation
- the subsurface; e.g., aquifers and soil moisture

The hydrologic cycle provides for a transfer of water from place to place depending on climatic conditions.

- atmosphere to land surface via precipitation.
- land surface to atmosphere via evaporation and transpiration (evapotranspiration)
- land surface to subsurface via infiltration and percolation

- subsurface to land surface via springs and vegetation
- land surface to land surface via overland runoff, and transport in waterways

As described earlier, flood hazards will result from the occurrence of large rainfall events in the Island. Additionally, historical analyses of flooding events in the island indicate that there is a correlation between these events and the incidence of several prior storms within a short time frame. These storms reduced the ability of the rainfall to infiltrate into the soil, resulting in a flood event. Other recent flooding events in the island demonstrate similar hydrologic behavior. For the Town of Hilton Head Island, preparation for and forecasting of flood events should account for this type of rainfall scenario.

4. Assessments of Associated Hazards

As described earlier, flood hazard mitigation primarily focuses on flooding events. However, these events often have associated hazards that bear discussion. In this study, these hazards include an investigation of wind and erosion issues.

A. Wind Hazards

Wind hazards in the Town of Hilton Head Island are generally related to tropical storms and hurricanes, thunderstorms and tornadoes. Of these, hurricanes tend to present the greatest and most widespread threat to the Island. Hurricanes will be considered in detail during this study.

Two aspects of wind hazards are of primary importance in the Town of Hilton Head Island are direct wind damage to structures, and damage to trees.

1) Structures

The 1997 edition of the Standard Building Code shows the 50-year design wind speed for the Island to be 100 mph. This wind speed is equivalent to a 120 mph 3-second gust speed. During Hurricane Gracie, *landfalling* wind speeds exceeded 95 mph[3]. The Town of Hilton Head Island Department of Building and Fire Codes enforces the 100 mph design wind speed for all new construction as well as for substantial improvements.

However, studies in Dade County following Hurricane Andrew (Insurance Research Council, 1995) found that residences constructed after 1980 were more likely to be heavily damaged and uninhabitable than structures built before 1980. Much of the reason lies in the quality of materials, construction techniques and inspections associated with the more recent structures. Unfortunately, a major hurricane might lead to similar results virtually anywhere. For these reasons, communities have instituted programs to review the condition of typical wood-frame residential structures, and develop retrofit programs where appropriate.

For older structures, built before adoption of modern wind resistant structural techniques, reduction of wind damage is achieved through a coordinated public education and structure retrofit program. While many older structures may survive low-velocity storm winds as well as or better than more recent construction, lack of maintenance in older structures renders them vulnerable to storm damage during high wind events.

[3] As shown in Table 1, maximum wind speeds for Gracie equaled 105 mph. Hurricane winds typically decrease when making landfall.

2) Trees

Recent experience with Hurricane Hugo in 1989 and Hurricane Fran in 1995 points out the potential impact of a strong hurricane on the tree canopy in Hilton Head Island. The City forester for Charlotte, NC, stated that over 2,000 street trees (trees adjacent to City streets) were lost during Hugo. Charlotte is approximately 200 miles from Hugo's point of landfall in Charleston, SC. Data from forestry departments in South Carolina and North Carolina both show widespread and significant loss of trees as a result of Hugo and Fran. Large areas with over 50 percent loss of trees were common over 100 miles from the coast during both storms.

B. Erosion Hazards

Erosion setback areas and baselines were determined by the State of South Carolina Office of Ocean and Coastal Resource Management (OCRM) and applied within Island ordinances. These lines provide another tool to assist in identifying areas of the Island that could exhibit flood hazard potential (OCRM, 1993). Studies in Florida note that properties seaward of the setback baselines suffered significantly more damage from a hurricane than landward properties (Shows, 1978).

Visual inspection of the 33 sheets that comprise Hilton Head reveal that, primarily, structures in the northeastern and northern portions of the Island fall seaward the baseline and setback boundaries. These structures are primarily within the Palmetto Dunes and Port Royal Plantation communities. This analysis generally agrees with the results of previous Island studies on erosion (HHI, 1991). These areas are especially vulnerable during the extratropical events that tend to generate long periods of severe wave action.

C. Waves

Waves can affect the Island in a number of ways. The most severe of which results from breaking wave forces that can be an order of magnitude higher than wind forces during storm events. Wave runup occurs as broken waves run up beaches and sloping surfaces. Wave runup can drive large volumes of water onshore, inducing fluid impact forces, drag forces, and lift forces. Wave reflection or deflection from adjacent structures or objects can produce forces on a structure similar to those caused by wave runup.

Shoaling waves beneath elevated structures can lead to wave uplift forces. The most common example of wave uplift damage occurs at fishing piers, where pier decks are lost close to shore, when shoaling storm waves lift the pier deck away from the pilings and beams. The same type of damage can be observed at the lowest floor of insufficiently elevated but well-founded homes. Finally, storm waves can also lead to significant erosion of beaches, dunes, and bluffs.

D. High-Velocity Flows

Floodwaters moving at high velocities can lead to hydrodynamic forces on structural elements in the water column, including drag forces in the direction of flow and lift forces perpendicular to the direction of flow. Oscillations in lift forces correspond to the repeated shedding of vortices from alternate sides of the structural element (for example, these vortices can often be seen in the wakes behind bridge pilings in rapidly moving water). High-velocity flows can also move large quantities of sediment and debris. Current "V" zone mapping procedures cannot accurately predict locations where high-velocity flows and their impacts will be felt.

High velocity flows can be created or enhanced by the presence of manmade or natural obstructions along the shoreline and by "weak points" formed by bridges or shore-normal canals, channels, and drainage features. For example, anecdotal evidence after Hurricane Opal struck Navarre Beach, Florida, in 1995 suggests that large engineered buildings channeled flow between them, causing deep scour channels across the island and washing out roads and homes situated farther landward. Observations of damage caused by Hurricane Fran in 1996 at North Topsail Beach, North Carolina, show a correlation between storm cuts across the island and ditches and bridge locations along the frontage road.

F. Assessment of Flood Problems

Given these sources of flood hazards, this study investigated associated flood related problems. These problems are related to physical and community features present on Hilton Head Island. Flood hazards can be characterized by both areas that are prone to damage during a flood event, and those areas having direct and indirect impacts on the Island during and after a flood event.

From the investigation of different hazard issues of concern in the Island, the study incorporated these into a series of analyses designed to assess current, relative vulnerability of the Island to these issues. These flood problems and areas of vulnerability are described below.

1. Stormwater Management Assessment

Stormwater management practices attempt to describe and control these surface and subsurface components of the hydrologic cycle. The most important parts of the cycle traditionally have been precipitation and runoff.

A reasonable assumption would be that, on the average, the amount of precipitation falling upon Hilton Head remains relatively consistent from year to year. The volume of water annually falling upon the island has probably not changed over the last 300 years (i.e., since the grant of the Island by English Lords Proprietors in 1698). Disregarding any external effects (global warming), the average annual amount of rainfall expected in the next 300 years should also remain constant[4].

Ultimately, runoff and infiltration components should also reach an equilibrium or balance. However, the increase of human activities on the Island during the last half-century has introduced a variety of changes to the environment that directly and indirectly affect the hydrologic process. Flood events are affected by these changes.

[4] A distinction should be made between the *annual average volume* and years considered especially *wet* or *dry*. Nor should any casual relationship exist between *annual average rainfall* and *individual events*. Those years and events that deviate from the average are those of most interest to people involved in the study of hydrology. For example, the Town of Hilton Head Island uses the 25-year, 24-hour storm event for design of recent stormwater management facilities (Thomas and Hutton, 1995). To study effects on fisheries, environmental scientists might be interested in periods when stream flows have decreased to levels that only occur, on average, every ten years.

The effects of these changes are cumulative. As development increases, less pervious area, vegetation, and other hydrologic factors are available to reduce the runoff. A metaphor would be to think of the Town of Hilton Head Island as a sponge. The spaces within this sponge represent the ability of the island to "absorb" (i.e., hold and transport) rainfall. When the Island was first settled, the "sponge" was relatively dry and could easily "soak up" excess rainfall. Flood events most likely occurred, but only during severe hydrologic events. As human activity increased, more and more of this sponge became filled with water. Since the rainfall volume is a constant, the excess water "spills" onto the island – appearing as a flood.

Although not perfect, this analogy provides an explanation of why many residents are noticing flood problems more and more often. The flooding is not necessarily present because someone built a home in that empty lot in the neighborhood. The flooding potential was present when the area first developed. The initial houses in that neighborhood produced increased stormwater runoff. However, the quantity of that runoff was hidden because it could drain onto that empty lot. When the new house was built, that runoff no longer had a place to go. In fact, as will be discussed, it might be argued that the new house, built under current development standards, contributes less runoff than its older neighbors do!

Like similar communities throughout the United States, the status of stormwater management in the Town of Hilton Head Island reflects the changes in technical and regulatory practices in flood control. These changes in stormwater management techniques are a result of increasing sophistication in understanding of the hydrologic process. They also reflect a desire to reduce risk to lives and property during precipitation events.

Stormwater management practices have evolved in the last half-century. Traditionally, early methods sought to convey stormwater "away" from dwellings and roadways (e.g., swales and ditches). Later techniques applied peak flow collection and dispersion devices (e.g., curbs, gutters, and storm drains). Fifteen years ago, proper practices began to consider stormwater volume quantity issues (e.g., application of stormwater management ponds) and quantity and quality approaches for stormwater management. Most recently, these have been refined into application of techniques that mimic pre-development hydrology by retaining more water on or near the site. Such techniques are sometimes referred to as low impact development (LID).

Additionally, the probabilistic criteria for determining an estimate of the rainfall have also changed. More recent practice has instituted less frequent design frequencies that in turn yield higher rainfall volume estimates, and larger hydraulic structures to convey and contain that volume (Thomas and Hutton, 1995).

Each time development occurred on the island, owners and developers used practices appropriate for the period. As stormwater management techniques improved, these were adapted into the regulatory framework and applied to subsequent developments. The result is a mixture of practices, each that control stormwater discharges to various degrees. The problem with mixing these techniques is that they do not necessarily compliment each other in terms of effectiveness. The cumulative effect does not satisfy current stormwater management practices.

Studies conducted by the Town of Hilton Head Island recognize this type of problem exists and propose solutions to combat these issues (Thomas and Hutton, 1995). Prior stormwater management studies and efforts have resulted in excellent and innovative technical solutions to flooding issues. Even with implementation of these solutions, wise flood hazard mitigation and CRS policy practices recognize that resolving these issues is an on-going process.

The Town of Hilton Head Island is investigating and addressing drainage and stormwater issues on a regular basis. The island has been divided into several drainage basins, within which drainage plans are being developed. These drainage plans identify specific projects and actions that can be undertaken to reduce or eliminate drainage and stormwater management problems. These studies assist in mitigation efforts and strategies by providing a engineering and economic set of priorities to identified and anticipated flood issues.

The Town is currently undertaking several programs designed to address stormwater management issues on the island. Appendix C presents information on these projects. The Appendix includes the project name, cost, and project description. The compilation includes both public and privately funded efforts. The geographic distribution of these projects provides an indication of the areas where flooding problems are widespread enough to merit attention by planners and engineers.

2. Structure Vulnerability Assessment

Having investigated the different hazard issues of concern in the Island, the study performed a series of analyses designed to assess current, relative vulnerability of structures on the Island to flood hazards. Notably, the 100-year event used in the FIS study.

A. Approach

Numerous properties in the Island intersect or are adjacent to mapped floodplains depicted on the FIRM. The study used assessment data supplied by the Town to investigate potential effects of flooding upon these structures. The study developed a model that linked these locations to estimated flood depth and applied structure flood damage functions to calculate flood damages to Hilton Head Island.

In the analysis, computation of flood damage to structures required four data elements:

- information on the type, number, age, value and location of structures on Hilton Head Island,
- anticipated water surface elevations from the 100-year FIS hurricane scenario,
- topographic information of the Island,
- damage functions relating structure damage to water elevation and structure type.

B. Flood Damage Analysis Methodology

The approach used in this study used GIS coverages and tools to apply these data elements in the following manner:

- Create a Flood Hazard Depth coverage using FIRM and topographic data
- Determine current (1998) value for those structures having available appraisal data
- Find the depth of flooding in each structure subject to flood hazard
- Categorize structure based on classified use and type
- Employ depth / value / type functions to determine potential damage to structure
- Use depth / value / type functions to determine potential damage to structure contents
- Aggregate and summarize damages

- Apply Census Bureau information to account for structure age (i.e., pre-FIRM / post-FIRM)
- Produce results and maps of structures vulnerable to floods

C. Data Applied in Analysis

Specific details on the data elements include:

1) Structure Classification

Structures were divided into one of five categories:

- *Mobile homes* -- Pre-engineered structures include manufactured housing and metal buildings that are mass-produced for shipment to or erection on site.
- *Other Residential structures* -- This includes most single-family structures and low-rise, one-to-four unit residential structures.
- *Commercial structures* -- structures built for institutional, governmental, professional, shopping, restaurant, and similar uses. Also included in this category are hotels and motels and higher density residential structures.
- *Recreational structures* –structures associated with recreational activities such as golf course buildings, marina facilities, and structures located in parks and recreational areas.
- *Other structures* -- Additional commercial structures that include warehouses, auxiliary, heavy commercial operations, and other miscellaneous structures.

2) Structure Data

Information on structure types, numbers, locations and values were taken from data for Hilton Head Island. The data was obtained from recent Town of Hilton Head Island and Beaufort County sources. From these sources, only those structures that included associated structure type, location, and 1998 assessed structure value (prior to the 1998 County wide reassessment process) were applied in the analysis[5]. The data does not include the value of land, purchase price, or (in most cases) include ancillary structures, such as garages. Table 5 presents a summary of the data used in the analyses.

3) Flood Damage Relationships

The study applied NFIP Actuarial Information System data to develop the flood damage relationships for the structure classifications (FEMA, 1998). These relationships allow consideration of structures with and without basements. To simplify the analyses, the study assumed that all structures on Hilton Head Island lacked basements.

[5] These values may not agree with estimates in other portions of the Comprehensive Plan. This is logical given the more focused criteria required for this analysis. Beaufort County assessor information indicates that there are approximately 33,000 assessed properties of one manner or another on Hilton Head Island.

Table 5. Hilton Head Island Structure Data.

Total number of structures	15,207
Mobile Homes	659
Other Residential	12,886
Commercial	774
Recreational	861
Other	27
Estimated value of structures	$ 3,214 million
Mobile Homes	$ 24 million
Other Residential	$ 2,390 million
Commercial	$ 556 million
Recreational	$ 225 million
Other	$ 19 million

D. Flood Depth Elevations

The creation of the flood depth elevations was accomplished by using GIS models to create a topological surface described by the difference between topographic contour elevations and 100-year floodplain surfaces. In the case of the floodplain, the elevation associated with each hazard zone was assumed to be the maximum expected value (i.e.; debris and additional wave effects were neglected). The studies assumed that the elevation datum applied by both data sources were equal and representative.

In the “B” zones areas, flood elevations were assumed to equal one foot. This assumption relates to FIRM descriptions of maximum flood depths in such areas. In “C” zone areas, no flooding was assumed to occur (although as described earlier, other analyses and studies suggest that these areas do have flooding resulting from other hydrological factors). However, to correspond to FEMA and U.S. Army Corps of Engineer (Corps) practices, the study recognized that some damages would occur even in these areas (Corps, 1993)

After establishing this topological flood depth surface, the study combined this coverage with pre-FIRM structure information to determine the location and degree of potentially flood damaged structures.

Table 6 presents a summary of the estimated potentially damaged structures from the 100-year flood event. These structures will be analyzed for this study.

Table 6. Potential Hilton Head Island Flood Damaged Structures.

Estimated number of potentially damaged structures	13,455
Mobile Homes	175
Other Residential	12,231
Commercial	580
Recreational	457
Other	12
Estimated total value of potentially damages structures	$ 3,100 million

E. Damage Aggregation Function

The study applied these components to determine the estimated flood damage. The study applied Corps (and others) flood elevation versus damage values to approximate the percentage of damage to structures and contents based on water surface depth (Corps, 1993, Cochrane, 1975). The formula used to calculate flood damages followed the general relationship given below:

$$D = \$ \times (S + C)$$

where:

D is the dollar value of flood damage to a structure (including contents),

$ is the dollar value of the structure,

S is the damage function percentage corresponding to the structure class and water surface level.

C is the damage function percentage corresponding to the structure contents and water surface level.

F. Adjustment for Structure Age

The study assumed that all residential and similar structures built after the Town of Hilton Head Island began participation in the NFIP meet appropriate flood protection criteria. However, the data available for the study did not include structure age. The data did contain information of the last date the structure was sold. Analysis of the "last sold" value indicated that only approximately 3 percent of structures have NOT been sold since 1980. This value is not supported.

To compensate for this lack of age data, the study assumed that the age of structures could be based on Census Bureau derived values found within the Housing Element of the updated Comprehensive Plan. These data have broken housing stock age into percentage within a temporal range, mostly based on decade (e.g., 1960 to 1969, 1970 to 1979, 1980 to 1984, etc.) up to 1990. The analysis added housing stock constructed after 1990 using Town of Hilton Head Island building permits information. Results of this analysis estimated that 9,983 houses out of

24,463, or approximately 41 percent, were built before 1980. Because of the temporal aggregation, the study assumed that structures built before 1980 did not meet NFIP standards (and structures built after this date did so). The study also assumed that these age percentages apply to all types of housing stock (including mobile homes, multi-family stock), commercial, hotel, and other non-housing structures.

In reality, September 1977 was the date of the first Flood Insurance Rate Map for the portions of Beaufort County, including Hilton Head Island. Structures built after this date met minimum standards for floodplain development. Because of limitations of the data source, the analysis can not reasonably break the 1970 to 1979 structural data into smaller temporal periods to include these structures. Therefore, the analysis estimates a larger number of floodprone structures than are actually located on the Island. The result is an estimate that predicts more potential damages than are likely to actually occur. Future investigations into these estimates should refine the data and analysis to improve these and other assumptions.

G. Analysis Results

Table 7 presents a summary of the estimated damages to structures from the 100-year flood event. The total estimate of damages if Hilton head Island was not an active participant in the NFIP would be $1.66 billion, not counting associated wave and wind effects. Assuming that 41 percent of all structures are pre-NFIP and not protected from the event, this would indicate that at least $680 million in damages could be expected to occur (this, of course, assumes that post-NFIP strucutres would not suffer any flooding damages).

Table 7. Hilton Head Island Structure Damages.

Estimated damages to structures	$ 680 million
Mobile Homes	$ 5 million
Other Residential	$ 581 million
Commercial	$ 75 million
Recreational	$ 18 million
Other	$ 1 million

Figure 4 illustrates the locations of these potential flood damages. As can be seen, there is no area of Hilton Head Island potentially not subject to these damages. This observation illustrates the overall vulnerability of the Island community to flood events of all types.

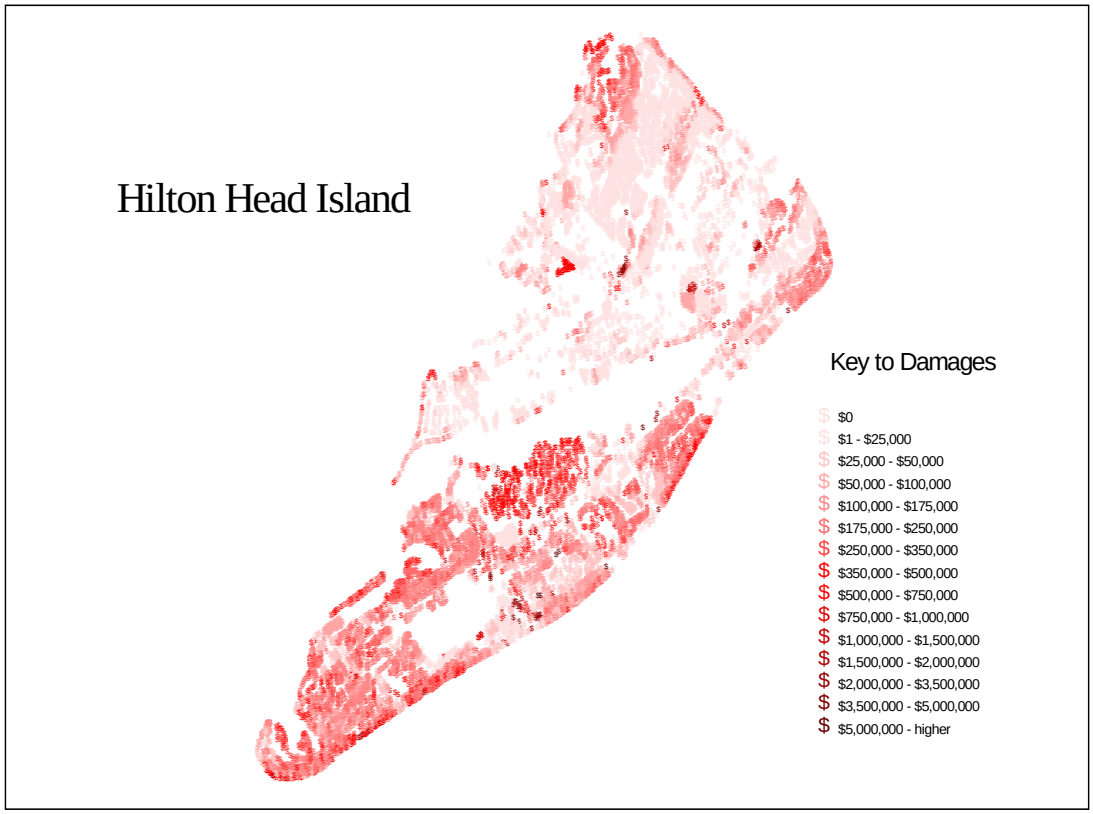

Figure 4. Potential Flood Damages.

3. Assessment of Infrastructure and Critical Facilities

Since the Island has such a large percentage of flood areas, events will have repercussions on many facets of the community and infrastructure. To illustrate flooding effects, an analysis correlated the incidence of congruence between the floodplain and critical facilities and sites within the Island.

The procedure used in the analysis overlays these key facilities and the floodplain to determine resulting areas of potential concern.

A. Schools

The study sought to determine the impacts of flood events on schools within the Island. The concern is that schools house thousands of children during each weekday and school facilities are used by the entire community for educational, recreation and other activities throughout the year. At the least, flood events will cause disruption to these activities.

B. Shelters

There are no storm shelters on Hilton Head Island. In case of a major storm, the entire community is evacuated to inland shelters. As with many other areas in the United States, emergency preparedness officials express some concern about the adequacy of these shelters to house evacuated populations. Many of these concerns are related to structure capacity and access.

C. Hospitals

When a large-scale event (such as a Hurricane) threatens the Island and forces evacuation, the Hospital will not be providing any care during or shortly after the event. Should the event cause significant damage, reentry would not occur for any portion of the general population until the Hospital was able to provide care. However, after sudden events where evacuation is not an option, the Hospital and other health facilities will serve as critical facilities for the treatment and care of injured, as well as providing on-going care to the remainder of the community. Additionally, in the case of a flood event, hospitals should expect the influx of citizens, including infirm and aged persons. During interviews, emergency management authorities expressed concern about the possible evacuation of residents of nursing and community facilities prior to a major storm event. As described in the population element of the comprehensive plan, the number of older residents possibly requiring such facilities is expected to grow.

D. Water & Wastewater

The water supplies in the Town of Hilton Head Island potentially face a variety of hazards during a flood event. First is the possible contamination of the Public Utility and private wells that furnish potable water. Another hazard is the loss of plant capacity resulting from floodwaters. Residents in areas served by private wells also face issues of contamination. A concern during and after the flood event is the ability to properly dispose of sewage. This manifests itself through submerged sanitary sewers, septic systems, and wastewater treatment facilities. During periods of high saturation, such as a flood event, a likely result will be reduction of the efficiency of such systems. Likewise, septic systems submerged by floodwaters could lead to possible health risks. In such cases, pathogenic organisms are introduced into the environment. Additionally, the higher saturation associated with such events may result in septic field failures. During the March 18, 1998 site visits, several areas of the Island were encountered that had completely flooded yards, including well systems and septic fields.

E. Hazardous Waste & Toxic Sites

According to public records, the Town of Hilton Head Island does not contain hazardous waste or other toxic release sites within its environs. However, the Island does contain buildings and other structures that have attached or associated fuel tanks. During flood events, these tanks tend to leak or break away. During a recent flood event in Delaware, half-empty propane tanks belonging to mobile homes began to float, broke away from foundations, and were deposited by wind and wave on a major roadway carrying evacuees and emergency equipment. In addition, on Hilton Head Island, lawn care chemicals and fertilizers present on golf courses could present another source of possible environmental hazards during a flood event.

There are no indications that any of these areas have actual problems or will have problems during flood events. However, they represent a source of potential mitigation activities and studies.

G. Flood Hazard Mitigation Activities

The Town of Hilton Head Island is involved in all manner of flood hazard mitigation activities. Some of these efforts have emerged in prior discussions in this study. In addition, the Town is active in additional activities and measures, described below.

1. Preventive activities

A. Open Space Preservation

As described more fully in the Natural Resources element, the Town of Hilton Head Island actively pursues land acquisition opportunities. For example, over the past 8 years, Hilton Head Island raised nearly $35 million for the purchase of open space through bond issues, grants, property taxes and real estate transfer taxes.

2. Property protection activities

A. Building Elevation

With the adoption of the NFIP by the Town of Hilton Head Island in 1977, the town also adopted building codes and practices designed to mitigate flood damages. The practices define two elevations to determine potential residential flood mitigation protection requirements. These elevations are the base flood elevation (BFE) and the furnished floor elevation (FFE).

The BFE refers to the water surface elevation associated with the 100-year event at a specific location. The FFE is the elevation of the lowest habitable floor including the basement. A structure is considered protected from flood impact when the FFE exceeds the BFE. The Town of Hilton Head Island requires that all new and substantially improved structures be elevated at or above the current BFE. Building permit records with elevation certificates are maintained in a permanent file for each structure.

B. Floodproofing

Commercial structures may be elevated as described or they may be dry floodproofed in accordance with NFIP regulations. The Town of Hilton Head Island maintains a permanent file for each structure and requests a yearly inspection of the floodproofing system.

C. Flood insurance

As of August 31, 1998, the Town of Hilton Head Island has 27,195 NFIP policies with associated premiums of $9,434,842 (NFIP, 1998). The total number of structures on the Island is approximately 33,000. This indicates that nearly 82 percent of all Hilton Head Island is protected under the NFIP.

These policies include both direct (140) and “write your own” (27,055) types and provide the community with $3,862,627,000 worth of coverage. As described earlier, the Town of Hilton Head pursues an active and on-going policy of educating the community of the benefits of such

policies. In return, these have assisted the community during flooding events: to date the NFIP has recorded 375 losses claimed for a total payment of $1,892,512 on the Island.

3. Natural resources benefits and protection

As described in the Natural Resources element of the Updated Comprehensive Plan, Hilton Head Island has already implemented activities to preserve open space, wetlands, and other natural portions of the Island. Comprehensive Plan goals encourage increased pursuit of such activities.

4. Review of structural projects

The Town of Hilton Head Island conducts on-going structural projects designed to assist in flood hazard mitigation efforts.

A. Beach Nourishment

Sand dunes and wide beaches protect inland properties by providing a barrier and breakwater for coastal storms. Maintenance programs can preserve these features and, in some cases, increase their size or effectiveness.

Beach nourishment excavates sand from offshore shoal systems and places it onto a retreating beach. The effectiveness of nourishment programs depend on the type of sand imported, the slope of the natural beach, cross shore currents, and the frequency of storms. There are no state requirements for routine dune or beach maintenance, so each community has been free to implement whatever practices it wants. Beach nourishment projects have been used to rebuild eroded beaches, generally every 5 to 7 years. This appears to be the practice in Hilton Head Island also. Hilton Head Island used a state appropriation in 1990, but now has a local accommodation tax which fully funds beach nourishment projects.

B. Sand Fencing

A goal of Sand Fencing projects are to develop new dunes in conjunction with the on-going beach nourishment efforts. Research has shown that placing sand fencing along re-nourishment projects enhances the development of new dunes. The sand fences disrupt the removal of the newly installed sand. This disruption causes the accumulation of the sand and thus develops a new dune creation area. Each area is planted with appropriate vegetation to further trap the sand and stabilize the areas. Overall, this entire process provides further protection to the nourishment project and to public property.

The Hilton Head Island Sand Fencing project consisted of five phases. Phase 1 occurred along North Forest Beach and other town owned properties. The project involved placing sand fence at approximately 17 feet offset from the existing dune vegetation and spaced in 10-foot increments. The fences were orientated in a V-shape at an angle of 120 degrees with each leg measuring eight feet. The Department of Health and Environmental Control – Bureau of Ocean Coastal Resource Management (DHEC-OCRM) mandated these measurements for survivability and effectiveness. The total length of phase 1 was 10,900 linear feet for a cost of $20,651. Phase 2 consisted of installing indigenous vegetation in the new dune creation area. This phase covered the area of the re-nourishment project of approximately 30,000 linear feet. As in phase 1, this project only involved placing of sand fence. The total cost of this project will be $45,603. The

final phases will be completed in the spring of 1999 with the planting of vegetation along phase 2 and installing sand fencing along the remainder of the public beach south of the re-nourishment project. With the completion of these phases, the entire public beach on Hilton Head Island will have newly installed sand fences to develop new dunes and provide better protection.

C. Drainage Improvements

The Island Wide Drainage Study investigated, identified, and prioritized minor and major stormwater and drainage improvements across the Island (Thomas and Hutton. 1995). The study identified a variety of measures and activities to alleviate flooding issues. The results of the study culminated into a stormwater management tool that contains:

- Composite map and inventory of storm drainage facilities.
- Listings of drainage bottlenecks for design events.
- Descriptions of measures and activities.
- Preliminary drainage improvement plans and cost estimates

The study also set priorities for implementation of these improvements. These are:

- Alleviating flooding that threatens human life, including access by emergency vehicles.
- Providing relief for the larger impacted floodprone areas and proceeding to smaller scale flooding areas.
- Solving isolated problems causing inconvenience to residents and others.

The cost for implementing the study recommendations was approximately $17.5 million. The study developed 17 projects and/or areas to implement these improvements. The Town of Hilton Head and others have already initiated the implementation process. To date, work has begun on the Jervis Creek and several other flood mitigation projects described in the study. The Town of Hilton Head Island anticipates construction of remaining projects in the future as dictated by the study prioritization and allocation of available funds.

H. Statement of Needs and Goals

From the investigation of current and possible activities and issues revealed through public involvement, flood hazard assessments, and agency coordination and review, this study refined a series of strategies and goals for Hilton Head Island. These strategies are grouped into four general areas: *Policies and Programs, Stormwater management, Technology,* and *Natural Resources*. Within each area, the study presents observations and recommendation related to mitigating flood hazards in the community. The format of these recommendations follows other portions of the updated Comprehensive Plan.

1. Policies and Programs

- ***Summary*** - The evolving nature of the Hilton Head Island community, as well as changing federal, state, and local programs obligates an awareness of the effects floods and flood mitigation efforts will have on people's public and private lives.

Need 1: The flood hazard mitigation process must continue to be a dynamic and on-going process for the Town of Hilton Head Island.

Goal 1: The policies, materials, and publications that have already been produced enabled the Island to be a leader in these types of efforts. The Island should maintain its program to continually review these items on a regular basis. In this manner, the Town can monitor how progress is being achieved in mitigation efforts. The Town should take the lead in creating new approaches and ideas in order to avoid complacency.

Need 2: All parties with a stake in the future of the Town recognize and discuss incentives and disincentives related to flood hazard mitigation practices. Most of the benefits of flood hazard mitigation relate to loss reduction, public welfare or public safety. Disincentives are typically identified as being related to lack of funding, staff or resources. This conflict between risk reduction and cost can hamper effective hazard mitigation. Effective hazard mitigation and post-disaster redevelopment require an explicitly stated and well-understood commitment from community leaders and decision-makers. Local government staffs are central to the overall process, but alone cannot and should not set policy for the community. Direction and policy setting for hazard mitigation must originate from an honest dialogue between island residents, the business community, elected officials, and staff.

Goal 2: The Town should institute a Local Hazard Mitigation and Planning Committee (LHMPC). Specific membership in the LHMPC would begin with the current members of the Town staff planning group. Additional members would include the Mayor, a resident of each Ward on the Island, members of the development, business, and real estate communities, a representative from the gated communities, and two "at-large" stakeholders. With the exception of the Mayor and managers, members will be nominated by the Town of Hilton Head Island Personnel Committee. To provide consistency in the flood hazard mitigation planning process, members will be asked to serve three year terms. The committee will report to the Town Council and other groups on a periodic basis. The LHMPC appointed members would act in an advisory role to suggest appropriate polices and activities to the LHMPC Town staff.

On a semi-annual basis, this advisory group would meet to define and refine community objectives for hazard mitigation. The LHMPC would also review and evaluate goals, objectives, progress, and policies of elements of the comprehensive plan to seek multi-objective projects and policies with regard to flood hazard mitigation. On a more frequent basis, the LHMPC may meet to review effects of ongoing Island activities and practices in regards to flood hazard mitigation.

Need 3: During a major hurricane event, catastrophic damage would be expected to primarily impact those structures built before 1977, the date of the the first Flood Insurance Rate Map.

Goal 3: The Local Hazard Mitigation and Planning Committee should investigate strategies and mechanisms to insure that all current and future structures on Hilton Head Island meet appropriate flood mitigation practices.

Need 4: If hazard mitigation and post-disaster recovery plans are largely ignored in the post-disaster context, and if local government comprehensive plans are thought to be irrelevant in the process, what then is the appropriate way to proceed? Smith and Deyle (1998) point out that for the situation to change, the planning process in

general and the local government comprehensive planning process in particular, must be altered so that hazard mitigation can be integrated throughout the process.

Goal 4: The Town of Hilton Head Island understands and is already engaged in this approach. Because the comprehensive plan (and its related land development and zoning regulations) remains the most influential force in day-to-day land use decisions at the local level, hazard mitigation efforts should focus there rather than on separate and distinct emergency and post-disaster plans. The latter should be concise summaries of applicable objectives, goals and policies of the comprehensive plan, along with necessary operational considerations. For this reason, the Town of Hilton Head Island should update these ancillary documents on a periodic basis, as needed. However, these documents supply the details that are not necessary in the comprehensive plan element.

Need 5: The Town should provide building officials with the regulatory tools required to implement flood hazard mitigation practices. The government charter that created the Town of Hilton Head mandates the structure and authority of town staff and managers. Part of this authority allows regulation of structures for flood hazard mitigation. However, the code does not provide regulatory officials with the authority to reach flooded areas without consent of gated community authorities. In the context of flood mitigation, this is not desirable.

Goal 5: Discussions should be initiated on the Island and County with the intent to allow flood hazard officials access to all areas of the Island. Ordinances should be developed that allow building officials and other responsible persons authority to inspect all areas of the Island to determine and respond to flood issues.

2. Stormwater Management

- ***Summary*** – Construction of flow control structures can help reduce flooding and stormwater management problems throughout the Island and its municipalities. It is apparent that local government hydrologists and engineers understand the nature and extent of the flood-related problems throughout the Island but are limited by funding for stormwater projects. Stormwater retrofitting seeks to re-design older drainage structures and appurtenances to meet recent practices. Retrofit opportunities for improving areas of older stormwater management practices should be actively investigated, evaluated for effectiveness, and implemented. These retrofit areas should be considered in addition to those areas identified in the Island Wide Drainage Study. Increases in flooding problems, stream channel degradation, non-point source pollution and the costs of stormwater management highlight the need to improve techniques for development on the Town of Hilton Head Island. One way to meet this need is through the implementation of Low Impact Development (LID). LID is an evolving philosophy of site design that emphasizes opportunities for enhancing the environmental performance of a site while taking into account the needs of the development community, the Island, and its residents and workers. LID is believed to have the potential for widespread applicability not only in initial site development, but also in the revitalization of previously developed areas. To effectively implement proposed changes to current practices, stakeholders must understand the impact of these changes on their interests. Intensive land development can alter the hydrologic balance of a watershed. LID strives to

employ techniques that permit developments to "lie lighter on the land" by mitigating the disruption of a parcel's hydrologic function.

Need 6: The Town should continue to determine and refine the extent of current flooding problems on Hilton Head Island based on feedback of citizens. The drawbacks of hydrology studies are that they use macroscopic techniques to investigate the effects of rainfall on watersheds. The methods used in the Island Wide Drainage Study are the most professionally, technically, legally, and economically viable means available to perform hydrology analyses in the Town of Hilton Head Island. However, application of these methods tends to miss more localized areas of flooding (when using TR-55 or similar methods, analyses do not provide hydrological information on parcel sized areas). The state-of-the-art does not exist to determine the locations of these areas. However, they exist and they affect residents of the Island.

Goal 6: The Town of Hilton Head Island should continue public involvement surveys of residents and businesses to determine the extent of flooding on the Island. Include "people friendly" questions designed to determine location, magnitude, and periods of events. The Town should take every opportunity to educate people on current efforts. The survey should be designed to allow entry into Town data management and GIS systems for analysis. The Town should analyze the survey results and compare with current vision of status quo. These points would be "ground truthed" and used to target areas for mitigation efforts. The Town should implement stormwater management policies that strive to ensure that the Island meets appropriate stormwater practices. This includes use of retrofit, land acquisition, and low impact development approaches. The information developed in the fifth goal should be applied to assist in determining priorities and techniques to apply.

Need 7: Maintenance of channels, trees, and other vulnerable areas is critical to mitigate potential flood and wind hazards. Coordination between public and private groups should improve to maintain existing and new stormwater appurtenances.

Goal 7: Efforts should focus on improving communication and coordinating responsibility between developers, property owners, and government for maintaining stormwater systems.

3. Technology

Need 8: Technologies useful in hazard mitigation can be classified as follows: data collection equipment and techniques; analytical and numerical analysis techniques; graphical and database packages, including GIS; communications systems and equipment; hazard warning systems; physical construction of protective or flow control structures; building codes for new construction; and retrofit techniques for existing structures. The Town of Hilton Head Island employs these technologies. In particular, the Island is rich in data in its various GIS operations. Refinement of these data and technologies will enhance hazard mitigation in the Town of Hilton Head Island.

Goal 8: The Town of Hilton Head Island should continue to maintain and improve this technological base. As an example, more precise information on the age of structures could allow more accurate determination of potential flood damages. A key to

extracting hazard mitigation-related information is cooperation between all involved parties, with a common goal of using available information and gathering future information to understand and reduce the vulnerability of Hilton Head Island citizens. Additionally, the Island should consider applying to FEMA for an updated FIS, using more recent data and models to permit development of more accurate flood zone limits.

4. Natural Resources

Need 9: The Town of Hilton Head Island provides an extensive canopy that adds to the natural beauty and livability of the area. Potential tree loss during a storm event is important for several reasons: loss of habitat and environmental benefits such as erosion control; additional damage to structures; blocked road and drainage systems; and the production of large quantities of vegetative debris.

Goal 9: One of the most important steps the Town of Hilton Head Island can take is to plan for handling and disposal of trees and limbs following a major storm. In addition to the collective knowledge and experience of Island and utility staff, guidance can be obtained from reports by USEPA (1995) and Dewberry & Davis (1993 and 1994). Annex Q of the Town's Disaster Preparedness Plan should be reviewed for adequacy in cases of tree damage and other sources of debris (HHI, 1997). The Town of Hilton Head should investigate and implement a strategy for the management and disposal of debris resulting from a flood and/or wind event. The issues investigated should include: prioritizing of areas to remove debris (i.e., removal of trees and limbs from access roadways to allow ingress of emergency vehicles); provision for common areas for citizens to transport and dispose of debris; negotiations with operators of waste management facilities, salvaging companies, towing facilities, and others for availability and use of these services in a post-event period.

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